PROJECT train mod:
modernizing soldier training through research

U.S. Army Research Institute
Special Report 57
June 2003

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ARMY RESEARCH INSTITUTE

ARI Special Report 57
June 2003

Foreword

It is hard to design a training program for equipment that exists only on a drawing board. Nevertheless, it is possible to get a head start on the conventional training research and development process, especially when behavioral scientists are able to either participate in or observe the early testing of prototype systems in the field. This principle is perfectly illustrated by Project Train Mod, which involved 11 separate research efforts across four general research areas: training modernization, decision making, situation awareness, and computer-based training for digital systems. During Project Train Mod our scientists were able to have an early influence in addressing a host of training and system design issues, particularly as they relate to the evolving Land Warrior system, the M2A3 Bradley Fighting Vehicle, and the many candidate systems evaluated during the Military Operations in Urban Terrain (MOUT) Advanced Concept Technology Demonstration (ACTD).

While highlighting the major findings of our work in Project Train Mod, this special report also demonstrates the kinds of soldier-oriented research activities we perform in the field, from pinpointing the source of excessive heat in the Bradley Fighting Vehicle to diagnosing the cause of shooting errors with the Land Warrior system. The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has a long and proud tradition of anticipating and solving the Army's toughest training problems, and we look forward to many more years of productive service to our nation's finest warriors - the soldiers of the U.S. Army.

Zita M. Simutis

ZITA M. SIMUTIS
Director

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Introduction and Overview

As the U.S. Army moves towards its ultimate Objective Force structure, leaders and soldiers will encounter many new high-tech systems and operational concepts. Small unit leaders will have to process and make decisions based on increasingly large amounts of information. Future battlefields will likely be characterized by rapidly changing situations, by threats that are difficult to define, and by multiple rules of engagement.

Although emerging technology solutions will address many of our future requirements, new classes of training problems will invariably accompany the introduction of this new technology. The full benefit of emerging information, weapons, and training systems will be realized only if new classes of training problems are clearly understood and remedied in a timely fashion. The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) launched Project Train Mod to address this concern directly.

Begun in 1998 at ARI's Infantry Forces Research Unit at Fort Benning, GA, Project Train Mod grew to encompass 11 separate lines of investigation across four general areas of applied training research. This report summarizes and highlights those 11 research efforts, grouped within four research areas:

- training modernization (5)
- decision making (2)
- situation awareness (2)
- computer-based training for digital systems (2)

The ***Training Modernization*** section focuses on training research for a variety of new systems and technologies. These include the evolving Land Warrior system, the M2A3 Bradley Fighting Vehicle, and myriad technologies evaluated under the aegis of the Military Operations in Urban Terrain (MOUT) Advanced Concept Technology Demonstration (ACTD) program.

The section on ***Decision Making*** describes our development of new computer-based training tools for soldiers learning to implement the Military Decision Making Process (MDMP). This section also provides an overview of a three-year research effort to teach platoon leaders to make better decisions during urban operations.

The ***Situation Awareness*** section highlights the creation of a comprehensive Infantry SA model, as well as the development and field testing of three new SA measures. Our work in this important area will continue in the coming years, as it investigates new methods for increasing soldier SA through training.

Finally, the section on ***Computer-Based Training for Digital Systems*** presents the major findings of our survey research on the computer backgrounds of different groups of soldiers. We then summarize the results of a series of learning experiments that assessed the effectiveness of different computer-based instructional design features for training on new digital systems.

Readers desiring more detailed information about a particular line of research should explore the ARI publications listed in the ***Additional Information*** sections of this report. Directions for downloading our technical publications are presented at the conclusion of the report.

Developing and Evaluating New Training for the Land Warrior System

ARI training assessments and observational field research provide a solid foundation for the design of new Land Warrior system training.

Problem. The Land Warrior (LW) system is the Army's future system for individual soldiers, both enhancing and integrating their ability to move, shoot, and communicate. Because most LW equipment is new to soldiers, providing them with combat capabilities never before realized, a number of operational and training development issues had to be addressed and resolved prior to system fielding.

Approach. In 1998 our researchers began conducting a series of training assessments of the LW's weapon subsystem components, including close combat optics, thermal weapon sights, and aiming lights. These assessments were made as part of the train-up for operational evaluations of the overall system. In the Summer of 2000, during preparation for the Joint Contingency Force Advanced Warfighting Experiment, we collected extensive observational data of a LW-equipped platoon during all of their classroom and field training prior to their going to the Joint Readiness Training Center (JRTC). Finally, we systematically examined the potential impact of integrating LW technology into the Infantry's existing institutional training programs.

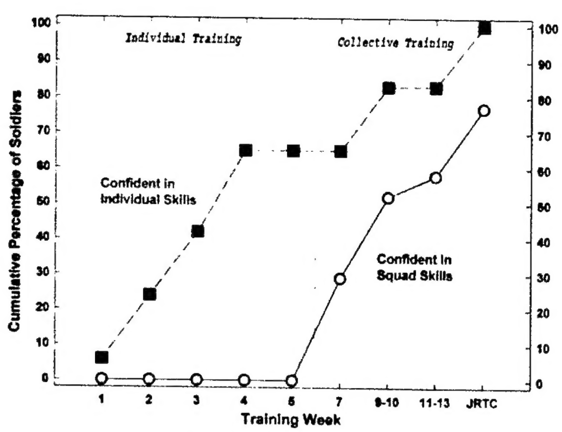
Results. We conducted the first training assessments where four different aiming or optical devices, plus a borelight, were trained simultaneously with the same soldiers. Previously, each device had only been examined independently. Two major lessons emerged from these weapon assessments:

- The inconsistency in design across devices created confusion, led to errors, wasted ammunition, and made training less efficient in general.
- Diagnosing shooting problems is more complicated than in the past because the number of potential causes for errors has increased almost exponentially.

Training observations of the LW-equipped platoon indicated that:

- Sizeable individual differences occurred in both time-to-train and in how soldiers employed the system. Future training for the LW system must be designed with this diversity in mind.

- After soldiers returned from the JRTC, they were asked to indicate when they had become confident in their own ability to operate the LW system during the train-up. They were also asked when they became confident in their squad's ability to employ the system. As shown in the learning curves below, reported confidence in individual skills preceded confidence in squad skills, though neither emerged instantaneously. These learning curves may be typical of many new systems as they are introduced to the force.



Subjective Individual and Collective Learning Curves

Payoff. Our recommendations for the enhancement of future LW training should give soldiers and leaders the confidence to use this new technology more intelligently and creatively as a combat multiplier throughout the full spectrum of hostile environments. Already, the results of our early training assessments have been used to develop a proposed Army-wide standard for weapons qualification with aiming lights.

Additional Information.

Dyer, J. L. (1999). Training lessons learned on sights and devices in the Land Warrior (LW) weapon subsystem (ARI Research Report 1749). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA371583)**

Centric, J. H., Wampler, R. L., & Dyer, J. L. (2000). Observations of infantry courses: Implications for Land Warrior (LW) training (ARI Research Note 2000-04). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA372853)**

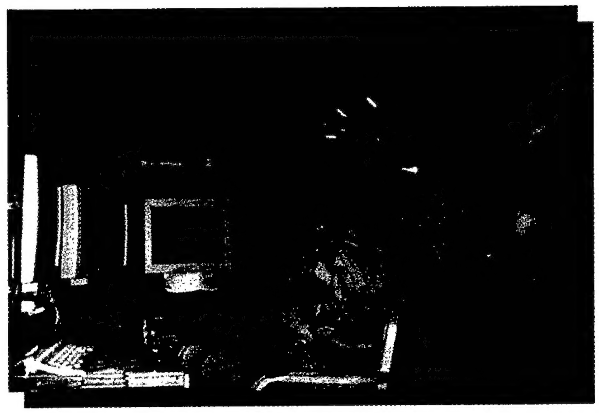
Evans, K. L., Dyer, J. L., & Hagman, J. D. (2000). Shooting straight: 20 years of rifle marksmanship research (ARI Special Report 44). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA384197)**

M2A3 Bradley Fighting Vehicle Training Modernization

As a key player in addressing soldier-oriented Bradley issues for the past two decades, ARI gauges the broad impact of new digitized fighting vehicles on institutional and unit training.

Problem. Unlike previous upgrades, the M2A3 Bradley is radically different from its predecessors. In response to the inevitable problems that surface during the process of initial fielding, the TRADOC Systems Manager for the Bradley and the U.S. Army Infantry School asked ARI to investigate a variety of training and training device issues surrounding the A3.

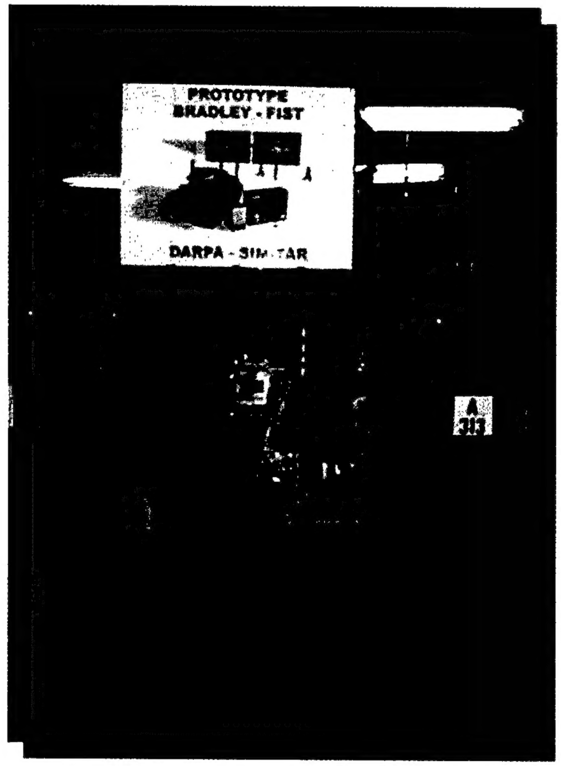
Approach. ARI's research staff collected training and operational performance data through soldier and instructor surveys, interviews, field observation, and hands-on participation. In addition, ARI conducted preliminary assessments of three prototype training devices for the A3, the Bradley Desktop Trainer (BDT), the Bradley Advanced Training System (BATS), and the Bradley Embedded Training System (BETS). We also conducted a limited user evaluation of the Full Crew Interactive Simulation Trainer-Bradley (FIST-B).



Results. Of the 85 proposed training tasks for the M2A3 Bradley, 37 (44%) were new tasks and 18 (21%) were predecessor tasks that required some modification for the A3. In fact, the M2A3 and M2A2 vehicles may differ more than the original Bradley differed with its predecessor, the M113 armored personnel carrier.

Overall, the A3 turret appears more technically demanding, while training and operational requirements are greater for soldiers and the unit master gunner. Additionally, A3 equipment is generally more complex, though not beyond the capabilities of well-trained operators, especially those with at least a moderate degree of computer familiarity.

A wealth of other findings has been detailed in a pair of ARI publications (see ***Additional Information*** below). Most of these other findings relate to either digitization issues, the impact of multiple vehicle variants on training, the impact of fielding the A3 and its training devices simultaneously, training materials, and personnel continuity.



Payoff. Results of our A3 training modernization research have been briefed to the requesting organizations, as well as to the 29th Infantry Regiment. These efforts have helped to alleviate some of the A3's fielding difficulties, and should make future vehicle upgrades less problematic.

Additional Information.

Salter, M. S. (1998). Full crew interactive simulation trainer-Bradley (FIST-B): Limited user assessment (ARI Research Report 1724). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA345818)**

Salter, M. S. (2001). Bradley fighting vehicle M2/M3 A3: Training and soldier system observations (ARI Research Note 2001-06). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA388153)**

Salter, M. S., & Rich, K. M. (2002). Preliminary user feedback of a prototype Bradley fighting vehicle M2A3/M3A3 embedded training system (BETS) (ARI Research Report 1800). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA408855)**

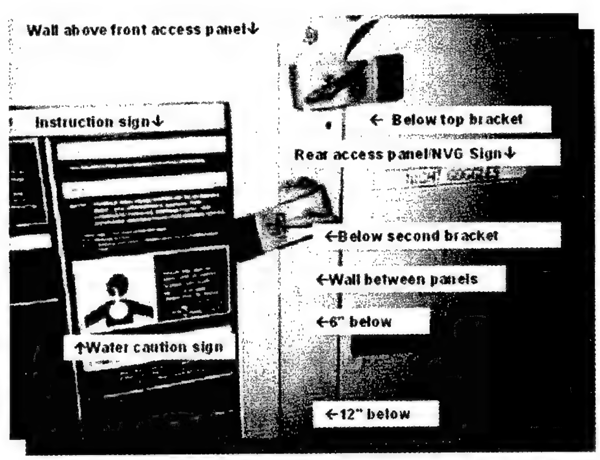
On the Hot Seat: Reducing Excessive Heat in the M2A3 Bradley Fighting Vehicle

ARI field research pinpoints the source of excessive heat in the driver's compartment, enabling the Program Manager and manufacturer to implement a simple fix.

Problem. Soldier complaints of excessive heat during training were confirmed at Aberdeen Proving Ground, where tests found the ambient temperature of the M2A3 driver's compartment to be as much as 35ø hotter than the M2A2. At the U.S. Army Infantry School's request, ARI conducted a series of tests at Fort Benning and Fort Hood to see if the source of the unwanted heat could be isolated and corrected.

Approach. With the engine idling, the turret power OFF, and the driver's hatch closed, a researcher sat in the driver's compartment and took ambient and surface temperature readings at 10-minute intervals over the course of a day. Surface temperature readings were obtained at 20 different locations within the driver's compartment. One M2A3 vehicle was tested at Fort Hood, followed by the testing of one M2A2 and two M2A3 vehicles at Fort Benning.

Results. Every driver's compartment surface adjacent to the engine was found to be hotter in the M2A3 than in the M2A2, and this effect became more pronounced as time wore on. In fact, some of these areas had surface temperatures greater than 150°. Temperature differences among the three M2A3 vehicles were negligible. This suggested the higher level of heat observed in the M2A3 was caused by the radiant transfer of engine heat into the driver's compartment.

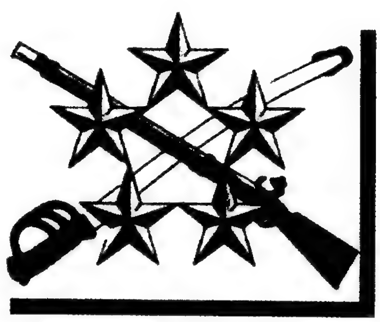


The highest surface temperatures in the driver's compartment were found here.

Payoff. After results were briefed to the Bradley TRADOC Systems Manager and the Program Manager-BFVS, additional insulation was added between the engine and the engine access panel in the driver's compartment. After installation on selected vehicles at Fort Hood, subsequent analyses indicated the extra insulation led to a considerable reduction in heat build-up.

Additional Information.

Salter, M. S., & Eakin, D. E. (2001). Bradley fighting vehicle: Heat in the driver's compartment (ARI Research Product 2001-01). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA389671)**



Training Impact Analysis Methods Based on Direct Observation

Observational methods of collecting training impact data can provide timely and accurate information for those making source selection decisions about new weapon systems, devices, and equipment.

Problem. Military test and evaluation programs may sometimes fail to consider important training issues when examining the relative merits of competing systems for a particular operational requirement. In particular, decision makers need better training impact information early in the product development cycle.

Approach. Methods for conducting a training impact analysis were developed and implemented within the context of an Operational Test (OT) of three medium antitank weapon systems and an Advanced Concept Technology Demonstration (ACTD) of 116 off-the-shelf technologies for urban operations. Data collected were mostly observational, consisting of time-referenced records that were recorded sequentially as they happened during the natural course of ACTD events. Between two and four observers were used at any one time, depending on the particular circumstances of each test. A training impact analysis forecasts or estimates the overall impact to institutional and unit training that a candidate system would have if it was selected for acquisition and fielding. Relative to a baseline technology or predecessor system, each candidate was ultimately judged to have either a positive, neutral, or negative impact on the training base. Training impact rankings of systems were based on the relative number of tasks soldiers had to learn and perform, the relative complexity and difficulty of each task, and the relative levels of training resources needed to achieve operational proficiency.

Results. In both the OT and ACTD, training impact differences were found among some or all of the candidates for most operational system requirements. For the purpose of illustration, selected results from three representative training impact analyses follow.

Relative Difficulty of Five Tasks Across Three OT Candidates (A,B, & C) and One Predecessor System (PS)

Task	Rank Order: Easy to Difficult
Engage Targets	A--B--C--PS
Maintain	A--B--C--PS
Prepare to Fire	A--B&C--PS
Restore to Carry Position	A--B--PS--C
Malfunction Procedures	A--B--C--PS

Estimated Complexity of Tasks Associated with Three Ballistic Shields

Tasks	Ballistic Shields		
	A	B	C
Employ offensively	1	2	3
Employ defensively	1	1	2
Operate light	1	1	1
Connect shields	•	•	2
Operate wheels	•	•	2
Total training complexity score	3	4	10

Note. The complexity of a task was estimated to be either low (1), moderate (2), high (3), or not applicable (•). Higher complexity scores indicate greater negative training impact.

Differences Among Five Hands-Free Radios and Associated Peripheral Components

Radio	Peripheral components	Required connections	NET minutes
A	2	1	32
B	2	1	39
C	2	2	43
D	3	3	54
E	4	6	61

Note. NET minutes = total New Equipment Training time provided by instructors.

Payoff. Training impact analyses based on methods of direct observation can provide source selection decision makers with accurate and timely training information relatively early in the product development cycle. In addition, training impact results can give training developers a head start in the design of training programs, devices, and materials prior to the acquisition and fielding of new systems.

Additional Information.

Evans, K. L., & Dyer, J. L. (2000). Direct observation in the conduct of training impact analyses (ARI Research Report 1757). Alexandria, VA: U.S. Army Research for the Behavioral and Social Sciences. **(ADA377177)**

Deciphering Platoon and Squad Radio Communications

ARI develops a new way to categorize the nature of radio transmissions in real time. It is being used to help identify and train optimal communication procedures for small-unit operations.

Problem. In the past only platoon and squad leaders were linked via radio. Squad leaders have typically communicated to squad members with either their voices or with hand signals. Now, an increasing number of small units are using radios to link all members of their squads and platoons. This has created some coordination problems not previously encountered. For example, problems can occur when all members of a squad or platoon attempt to communicate via a single channel, particularly if no restrictions are placed on who can transmit or when they can transmit.

Approach. As part of the MOUT ACTD program, recent research has attempted to identify the most efficient and accurate communication procedures to use with small unit radios. In support of that effort, ARI sought to categorize and measure the types of radio communication found in small units. Our early experience with an existing scheme for categorizing communications was problematic. It was difficult to use in real time, without benefit of tape recordings that could be replayed, and it led to a high rate of disagreement among different raters. For that reason, we developed a simpler scheme that could be used to quickly code, in real time, any type of radio transmission one might expect to encounter. This new method of communication measurement was based on 15 categories, as shown below.

Categories of Radio Communication

1. Provide Acknowledgement
2. Provide Direction
3. Provide Information about Friendlies
4. Provide Information about Threat
5. Provide Opinion

6. Request Acknowledgment
7. Request Direction
8. Request Information about Friendlies
9. Request Information about Threat
10. Request Opinion

11. Unrelated to Mission
12. Administrative/Other
13. Inaudible
14. Break Squelch
15. Hot Microphone

Results. Our new method of categorizing small unit radio transmissions was found to be highly reliable, with a level of agreement exceeding 97% between two raters. Although the search for the best small unit radio procedures is ongoing, we have noted four consistent trends in the communication data collected so far:

- Almost half of the all squad and platoon radio transmissions were concerned with requesting and providing acknowledgments.

- Transmissions that requested or provided information about a threat were more frequent during defensive missions than during offensive missions.

- Transmissions unrelated to the mission were more likely to occur when the squad or platoon was not in contact with the enemy.

- Most of the information flowing down the chain of command was concerned with the status of friendly forces, while most of the information flowing up the chain was concerned with the disposition and nature of the threat.

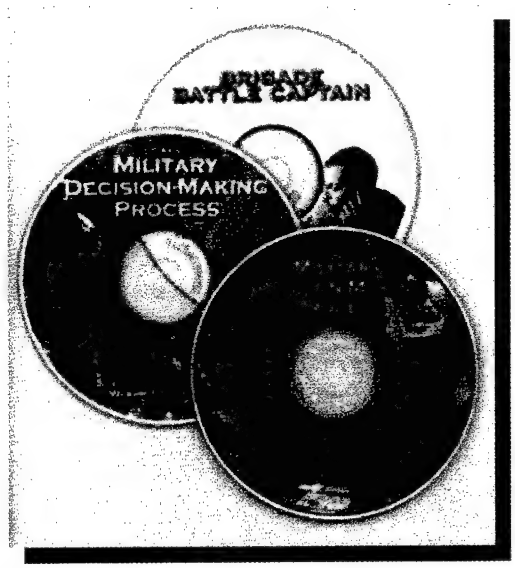
Payoff. Our new method of categorizing radio transmissions appears to be a useful tool for conducting communication research in small unit settings. It is both reliable and sensitive to the effects that different missions have on the way soldiers communicate. We recommend its continued use in future research.

Additional Information.

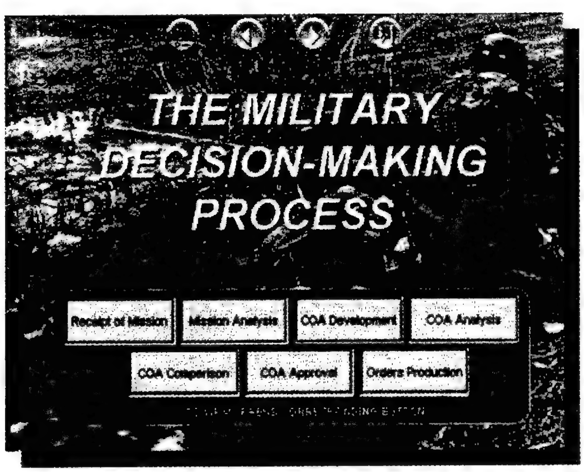
Christ, R. E., & Evans, K. L. (2002). Radio communications and situation awareness of Infantry squads during urban operations (ARI Technical Report 1131). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA405850)**

Mastering the Military Decision-Making Process

ARI introduces a series of three new computer-based training products, each with its own target audience, to help individuals and staffs learn how to successfully implement the Military Decision-Making Process (MDMP).



Problem. ARI research has shown that training for most unit staff positions is either absent or occurs only after incumbents have been in their positions for some period of time. Typically, staffs are not together long enough to develop and practice effective SOPs to facilitate their mission planning and decision-making tasks. Combat Training Centers have observed that most units do not do an adequate job of implementing the MDMP, even though they know what the basic process entails.



Approach. Training content was based on doctrine (FM 101-5, Staff Organization and Operations, 1997) pertaining to the seven-step MDMP, task analyses of staff positions, and Center for Army Lessons Learned materials related to tactics, techniques, and procedures (TTPs). Separate MDMP courses of instruction were created for Brigade and Division staffs. An adjunct course was also created for the Brigade Battle Captain.

Frequently, the MDMP must be executed in a time-constrained environment. For that reason, our Brigade MDMP course offers suggestions and TTPs for accelerating MDMP planning, though the completion of all seven steps is still emphasized.

Course materials were designed to train new staff members, as well as to provide refresher training on specific tasks. Lessons can be accessed in any sequence desired, and are appropriate for individuals with a wide range of staff experience.

Results. Interest from users has been enthusiastic and steady. For example, since 1998 we have distributed over 1,500 copies of the Brigade Battle Captain course to interested individuals and units. Current supplies of these courses have been exhausted.

Payoff. Although ARI no longer has copies of the courses for distribution, the Leader Training Program at the Joint Readiness Training Center continues to provide copies of the Brigade MDMP course to unit staff personnel prior to their scheduled rotations. The U.S. Army Command and General Staff College provides copies of the Division MDMP course to its resident and non-resident students.

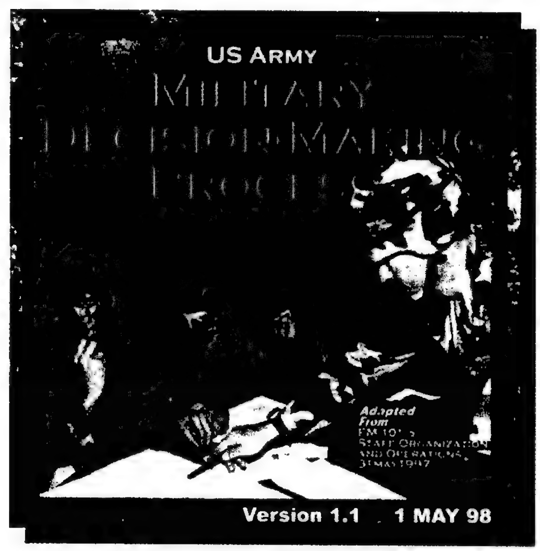
Additional Information.

Wampler, R. L., Centric, J., & Salter, M. S. (1998). The military decision-making process (MDMP): A prototype training product (ARI Research Product 98-33). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA343154)**

Wampler, R. L., Centric, J., & Salter, M. S. (1998). The brigade battle captain: A prototype training product (ARI Research Product 98-36). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA347093)**

Centric, J. H., & Salter, M. S. (1999). The division level military decision-making process (MDMP): Design and development of a prototype computer-based training product (ARI Research Report 1738). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA361259)**

Fober, G. W. (1999). Assessment of two computer-based products: The military decision-making process and the brigade battle captain (ARI Research Note 99-33). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA368209)**



Training Platoon Leaders to Make Better Decisions in Urban Operations

Principles of Naturalistic Decision Making are applied to the challenges platoon leaders face when making decisions in urban operations.

Problem. New platoon leaders are among the least experienced decision makers in the Army, particularly when challenged by exceedingly complex missions such as those encountered during Military Operations in Urban Terrain (MOUT). Funded by a Small Business Innovative Research contract with Klein Associates Inc., this research effort first sought to thoroughly identify the decision-making requirements of platoon leaders in one important MOUT task, "Clearing a Building". It then sought to develop and evaluate a training program aimed at teaching platoon leaders to make better decisions when confronted with that difficult, but important task.

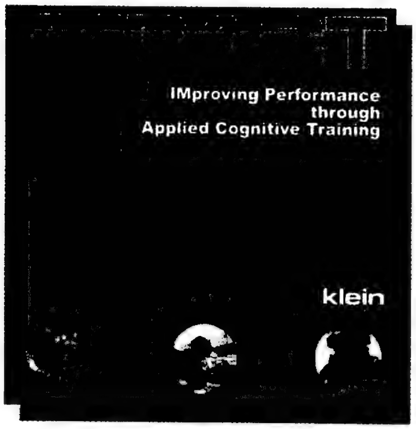
Approach. Based on a series of in-depth interviews with a small, but select group of highly experienced urban combat veterans, a Cognitive Task Analysis was performed on the building-clearing task from the perspective of the platoon leader. This analysis identified and detailed six task-focused and five task-independent decision requirements. Researchers then identified the cognitive demands associated with each task, including critical judgments, sensory cues, specific factors to be considered, and a variety of expert strategies that could be used.

Clearing a Building

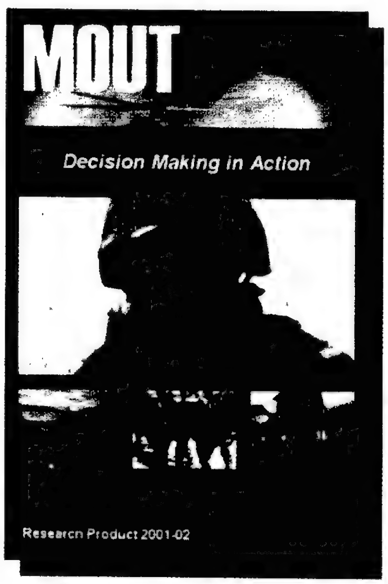
Task-Focused Decision Requirements
- secure the perimeter
- approach the building
- enter the building
- clear the building
- maintain and extend security
- evacuate the building

Task-Independent Decision Requirements
- maintain the enemy's perspective
- lead subordinates
- maintain the big picture and situation awareness
- project into the future
- understand and apply rules of engagement

Instructional materials were developed to teach the 11 decision requirements to platoon leaders using a series of 16 Decision-Making Games (DMGs), each presenting a unique scenario related to the clearing of buildings in MOUT. A CD-based instructor training program was created around the 16 DMGs. The CD was titled "IMproving Performance through Applied Cognitive Training" (IMPACT). It provides instructors with the materials needed to teach platoon leaders the decisions they must make when given the mission to clear a building. The CD highlights videotaped segments illustrating both model and undesirable instructor behavior and it provides teaching and discussion points for each DMG.



After the IMPACT CD was developed, it was evaluated at the United States Military Academy, using West Point cadets and instructors. In addition, a special publication detailing the results of the Cognitive Task Analysis, minus the technical jargon, was developed for a wide military audience.



Results. Although West Point cadets who received two hours of IMPACT training did not perform significantly better than cadets who received the same instructional material in a traditional After-Action-Review format, instructors thought IMPACT to be a valuable and highly usable training tool.

Payoff. As the existence of these instructional materials has become more widely known, the rate at which we receive requests from Army units and other research organizations has increased. Although its ultimate payoff will not be known for some time, IMPACT appears to fill a void in the MOUT training of new platoon leaders.

Additional Information.

Phillips, J., McDermott, P. L., Thordsen, M., McCloskey, M., & Klein, G. (1998). Cognitive requirements for small unit leaders in military operations in urban terrain (ARI Research Report 1728). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA355505)**

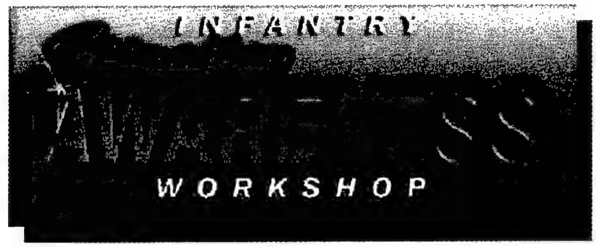
Klein Associates Inc. (2001). MOUT: Decision making in action (ARI Research Product 2001-02). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA391474)**

Phillips, J., McCloskey, M. J., McDermott, P. L., Wiggins, S. L., Battaglia, D. A., Thordsen, M. L., & Klein, G. (2001). Decision-centered MOUT training for small unit leaders (ARI Research Report 1776). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA394066)**

Pliske, R. M., Militello, L. G., Phillips, J., & Battaglia, D. A. (2001). Evaluating an approach to MOUT decision skills training (ARI Technical Report 1122). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. **(ADA399392)**

An Infantry Situation Awareness Model

ARI introduces and adapts Situation Awareness (SA) research and theory to the complex and practical world of Infantrymen.

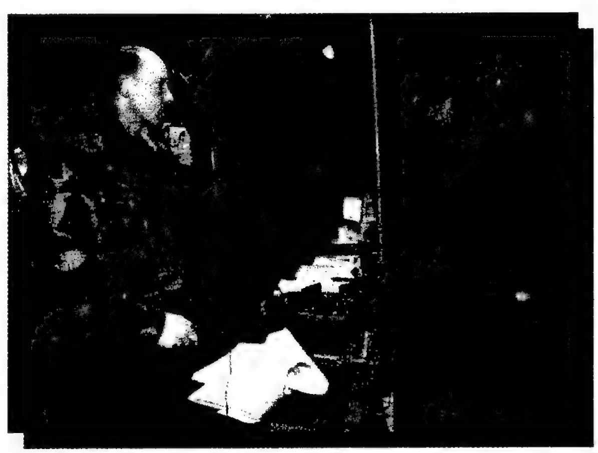


Problem. As the Army continues to integrate advanced technologies into its force, soldier SA is increasingly being seen as a determining factor in battle outcome. Although early thought and research about SA focused primarily on applications within the aviation community, ARI sought to demonstrate that this line of research could be beneficial to ground forces.

Approach. In 1998 ARI sponsored a two-day Infantry Situation Awareness Workshop at Fort Benning, GA. Its objectives were to develop SA requirements and performance measures for individual combatants and teams, to establish open dialogue between the research and warfighting communities, and to identify for future training, leader development , and soldier research.

Following a series of invited addresses, workshop participants were assigned to one of four working groups. Co-led by a retired General Officer and a noted civilian SA researcher, each group focused on either (1) individual combatants and squads, (2) platoons, companies, and battalions, (3) Infantry brigades, or (4) future Infantry teams. All four groups were asked to explore a common set of key questions:

- What are the most critical Infantry SA requirements and how are these linked to combat effectiveness and operational readiness?
- What new training techniques and approaches are needed?
- What pitfalls should the Army try to avoid in its drive to enhance SA?
- How can we assess SA in Infantry soldiers and teams?
- What are the most critical training, leader development, and soldier SA research issues that the Army should address in the next five years?



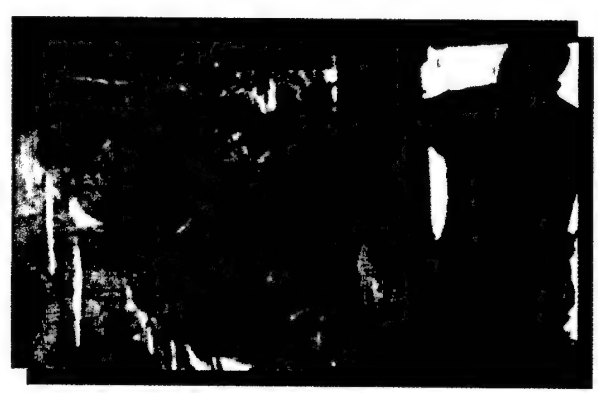
Results. Final workshop proceedings were archived in a special ARI publication (see the ***Additional Information*** section for its reference). A summary of each group's deliberations and conclusions about the aforementioned SA questions were presented separately in that publication.

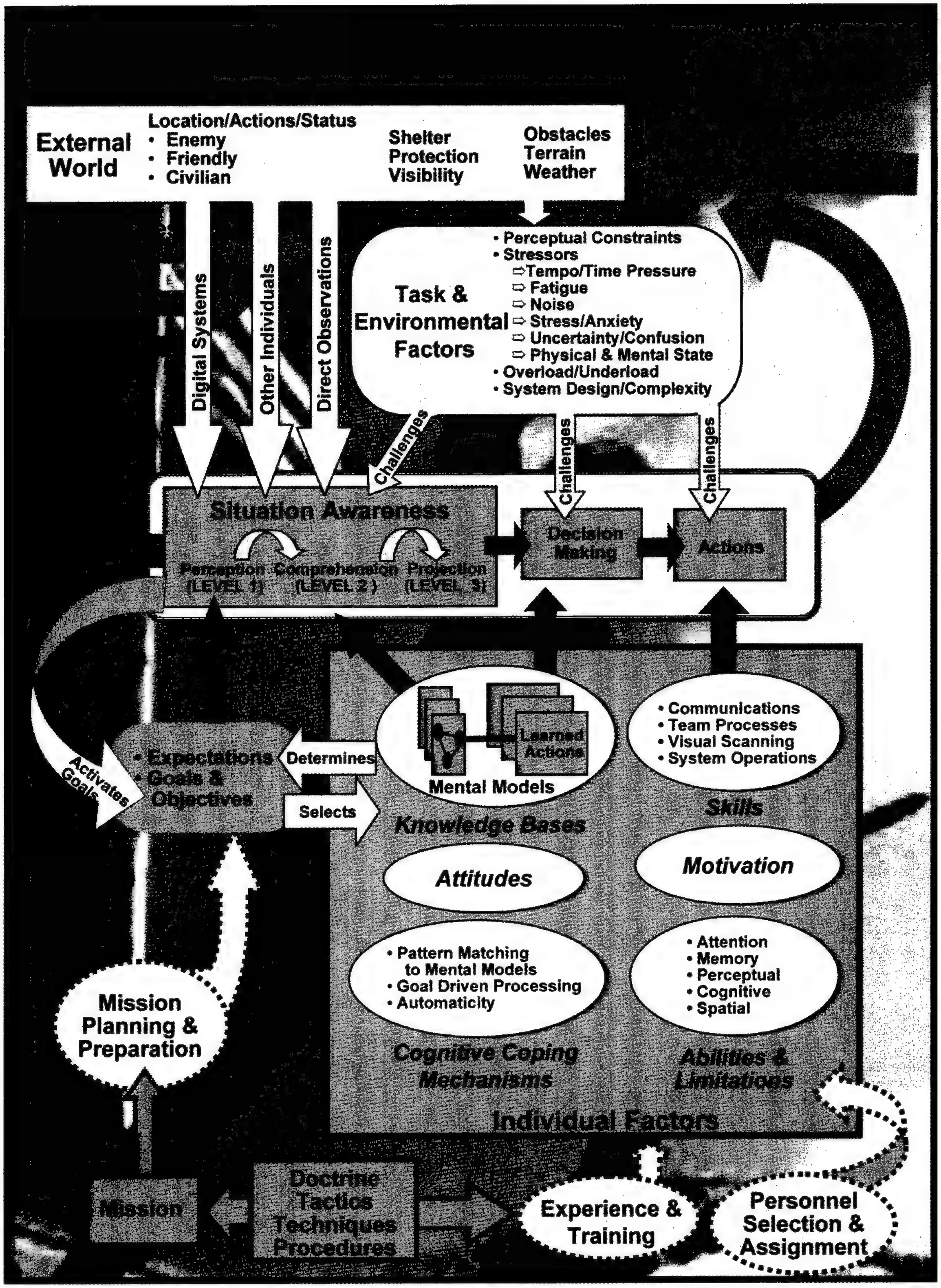
Subsequent to the Infantry SA Workshop, a select group of participants met to further develop SA concepts and measures within the Infantry operational environment. Specifically, this select research team analyzed the Infantry environment based on the tactical parameters of mission, enemy, terrain, troops, time available, and civilian considerations (METT-TC) at various echelons from the individual soldier to brigade level.

The primary products of this analysis were the development of individual and team models of Infantry SA, as well as a comprehensive set of recommendations for SA measurement and research focused on specific Infantry SA requirements.

As a prelude to the development of a computer-based Infantry SA trainer, SA Technologies, Inc., conducted an analysis of Infantry SA training requirements. This research effort, along with a companion effort by ISX Corporation to develop web-based SA training, was funded by OSD through Small Business Innovative Research contracts. ARI is monitoring this work through the end of FY03, when their prototype SA trainers are scheduled for delivery.

Payoff. These research efforts have provided a solid foundation and roadmap for the systematic investigation of SA concepts within the Infantry. In particular, they have guided the development of a variety of new SA measures (see next section) and inspired novel training development activities focused on high-priority Infantry combat requirements.





An Infantry-focused Model of Individual Situation Awareness.

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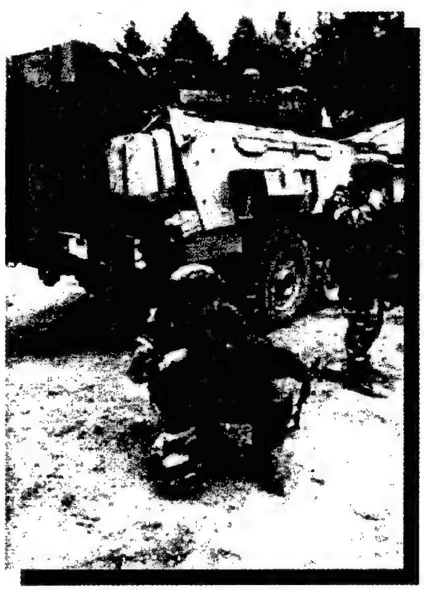
New Measures of Situation Awareness

ARI seeks to develop new, more user-friendly measures of Situation Awareness (SA). Three look promising.

Problem. Many Army trainers find traditional SA measures to be either too intrusive (i.e., because they require an exercise to be halted so measurement can take place) or too complicated (e.g., because a different measure must be customized for each mission). ARI hopes to develop some new measures of SA that are as good scientifically as more traditional measures, while being less intrusive and complex for soldiers to use.



Approach. Three prototype SA measures were designed by separate individuals or groups working independently of one another. Major design differences among these new measures are summarized below.

The Situation Awareness Behaviorally Anchored Rating Scale (SABARS) has 28 items, each with a five-point response scale ranging from "very poor" (1) to "very good" (5). When warranted, each item can be rated as "not applicable." Instructors or observers use the scale to rate the SA of individual platoon leaders.

The Mission Awareness Rating Scale (MARS) is a self-report measure having eight items. Each item has four response options, though these response options vary across items. The first four questions deal with a soldier's ability to detect and understand important environmental cues. The last four questions ask how difficult it was to detect and understand those cues. This scale can be completed by either leaders or their subordinates.

The Radio Communications Checklist of Leader Awareness (RCCOLA) is a 60-item checklist of communication behaviors that reflect either outstanding, typical, or poor levels of SA on the part of platoon or squad leaders . If radio transmissions of a leader to both his superiors and subordinates can be monitored for at least one-half hour, the checklist can be used to gauge that leader's level of SA in real time. An overall score is obtained by subtracting the number of poor behaviors checked from the number of outstanding behaviors, then dividing by the total number of outstanding, typical, and poor behaviors. Single items can be checked more than once as behaviors are repeated.

A typical SABARS item:

2. Solicits information from squad leaders.

1 Very Poor
2 Poor
3 Borderline
4 Good
5 Very Good
6 Not Applicable

A typical MARS item:

3. How well could you ***predict*** what was about to occur next in the exercise?

____ very well - could predict with accuracy what was about to occur
____ fairly well - could make accurate predictions most of the time
____ somewhat poor - misunderstood the situation much of the time
____ very poor - unable to predict what was about to occur

Three RCCOLA items that reflect outstanding, typical, and poor SA, respectively:

____ when asked for a SITREP while actively engaged with the enemy, can immediately respond with accurate information.
____ reports enemy activity in his area to the higher element.
____ fails to designate a new element leader when one of them becomes a casualty.

Results. Though early evaluative results have been encouraging, it would be premature to suggest how good or bad these new SA measures are at present, as the results to date have been based on relatively small samples of soldiers. Research is planned in the near future to address this concern.

Payoff. Evaluating the efficacy of a variety of new digital technologies often involves the issue of how such systems enhance a soldier's level of SA. If they prove to be reliable and valid predictors of true SA, the three measures described herein will make evaluations of new technology more timely and less costly, compared with traditional methods.

Additional Information.

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Surveying the Computer Backgrounds of Soldiers

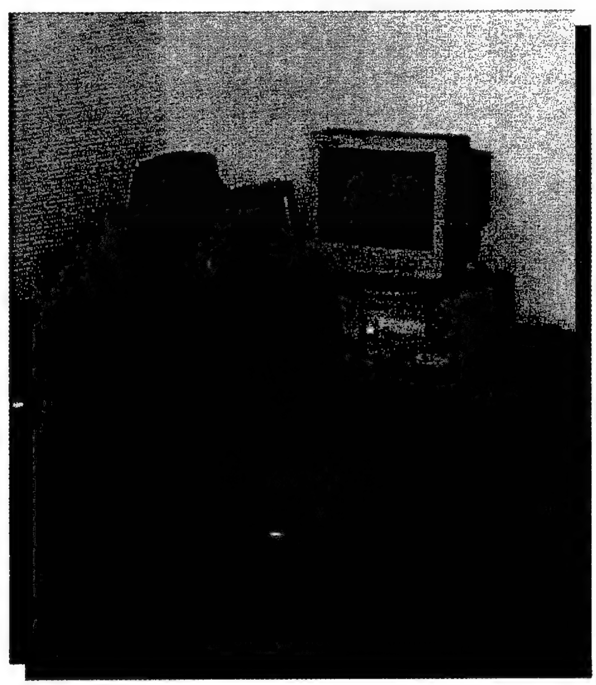
ARI surveys the computer backgrounds of different soldier groups over a three-year period. Some of our findings may really surprise you.

Problem. As digital systems become more commonplace throughout the Army, trainers ponder the best ways to prepare soldiers to operate those systems. Some assume that younger soldiers are more computer literate than their older counterparts. Yet, we really know very little about the actual computer backgrounds of soldiers. For example, one central training development question is whether soldiers need some amount of basic computer skills training before they learn to tackle the user requirements of new digital systems.

Approach. Soldiers attending four Infantry courses were surveyed each year from 1999 to 2001. A total of 2,135 completed surveys were obtained from those attending Infantry One Station Unit Training (OSUT), the Basic Noncommissioned Officer Course (BNCOC), the Advanced Noncommissioned Officer Course (ANCOC), and the Infantry Officer Basic Course (IOBC). In addition, surveys were completed by 1,334 soldiers in seven U.S. Army Forces Command (FORSCOM) battalions during 2000 and 2001.

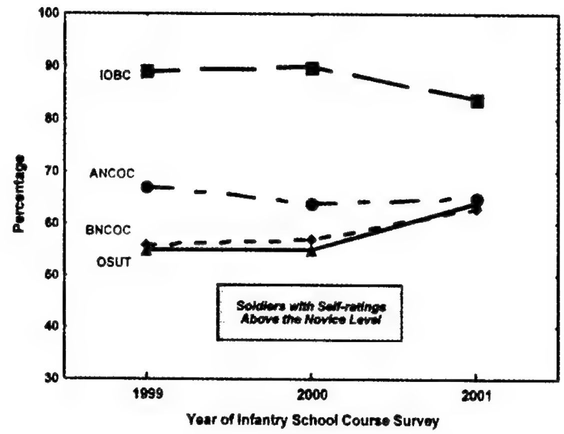
The survey focused on three issues, namely computer ownership, use, and expertise. Computer expertise was measured with a combination of self ratings, a test of the meanings of 18 different computer icons, and self-reported familiarity with various software programs and programming languages.

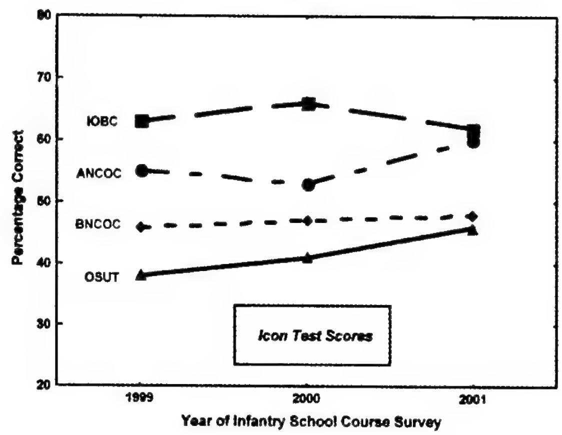
Results. Computer ownership increased over time, from an average of 67% in 1999 to 77% in 2001. Ownership rates were found to be highest in IOBC and ANCOC, though the greatest increase occurred between 1999 and 2001 in BNCOC. In the FORSCOM sample, which was more heterogeneous, ownership increased from 52% in 2000 to 57% in 2001. Overall, privates were least likely to own computers.



The Percentage of Computer Ownership Among Infantrymen in Four Courses

	Year of Survey		
Course	**1999**	**2000**	**2001**
IOBC	81%	81%	79%
ANCOC	78%	81%	90%
BNCOC	60%	68%	79%
OSUT	49%	53%	59%





Computer use in high school varied with a soldier's age, with younger soldiers more likely to have used computers in high school. In contrast, current use was relatively high across all groups, with 86% of OSUT soldiers and 96% of BNCOC, ANCOC, and IOBC soldiers indicating they used computers currently, either at home or at work.

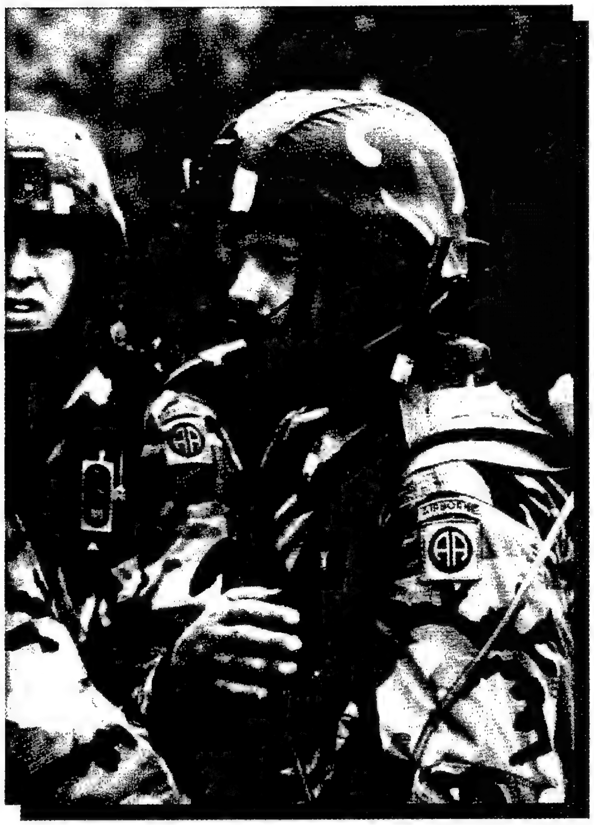
Soldiers reported using certain computer features more frequently than others. For instance, over half of the soldiers reported using a mouse on a daily basis between 1999 and 2001. Over half also reported using the internet and email on a daily basis in the 2001 survey. However, only about 20% of the soldiers surveyed said they used a computer's graphics capabilities. While mouse, internet, and email usage increased over time, graphics usage did not.

IOBC soldiers were highest in terms of computer expertise, followed by ANCOC, BNCOC, and OSUT in that order. However, these group differences seemed to narrow a bit over time. For FORSCOM soldiers, self-ratings of expertise and icon test scores increased with rank. Additionally, we found computer expertise to be higher among those in staff positions, regardless of rank.

One of the more remarkable outcomes of our survey research was the consistency of its findings. Specifically, five stable trends in the computer backgrounds of soldiers were identified:

- Consistent ordering by soldier rank on computer ownership and expertise.
- Linear increase in percentage of soldiers using computers in high school over a span of 25 years.
- Gradual increase in email and internet use.
- Gradual increase in computer experience and expertise.

- Opportunities to use computers in a military environment had a positive impact on the perceived ability and actual expertise of soldiers.



A soldier moves his cursor while looking at a computer-generated display on the v0.6 Land Warrior system.

Payoff. Although the overall soldier population is becoming more computer literate, it would be a mistake to conclude that all soldiers have equal proficiency, or that the youngest soldiers are the most proficient.

The results of our computer background surveys have relevancy in the design of effective training programs for new digital systems. While some soldiers could benefit from basic computer skills training, not all would either want or need it before receiving training in new digital systems. Because our computer background surveys only take about 10-15 minutes to complete, they could be readily used as a screening tool to identify those soldiers needing preliminary training in basic computer skills.

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Evaluating the Design of Computer-Based Training (CBT) for Digital Systems

ARI conducts soldier learning experiments to identify the most effective CBT design features to use for new systems like the Army's Land Warrior.

Problem. The most central component of a digital system is its computer software, whose operation soldiers must master before the system can be used effectively. CBT and interactive multimedia applications are expected to have increasingly greater roles in helping soldiers to overcome software learning challenges. How to best design CBT applications for such purposes has largely been a matter of theory and opinion, until now. Our research provides some concrete answers to several important CBT design questions.

Approach. A stratified sample of 168 soldiers from four Infantry courses participated in our research, which was conducted in two phases. In the first phase, soldiers were asked to learn a series of five-character alphanumeric codes for displaying individuals and units on a digitized map. In the second phase, soldiers were asked to learn seven map reading and display manipulation procedures (e.g., zoom in, zoom out, and display others). At the end of each phase, soldiers completed a final exam to measure how much they had learned. All training was computer-based and self-paced. No instructors were present.

Our research also compared three different approaches to CBT. In one approach, low demands were placed on a soldier's working memory. Lessons and exercises were designed around relatively small chunks of information. In contrast, a second approach placed high demands on working memory, because much greater amounts of information were presented before the information could be applied during practical exercises. Lastly, we examined an exploratory approach to CBT in which soldiers were told what they had to learn, but not how they should go about learning it.

Results. For both code and map skills, the low demand approach to CBT was the most effective. However, soldiers completed their training and testing more quickly when the exploratory approach was used. In addition, some consistent differences among the soldiers were found across Infantry courses.

Officers tended to achieve the highest performance scores in the shortest amount of time, while basic trainees tended to achieve the lowest scores in the greatest amount of time.

A follow-on experiment compared variations in exploratory approaches. Initial results again showed that a pure exploratory mode of training was not effective, particularly for younger soldiers in basic training. Training conditions having practice exercises worked the best. Low-demand instruction combined with practice exercises appeared to be equally effective to an aided discovery approach. The aided discovery approach has no formal instruction, but incorporates exercises that limit the functions to be explored and provide performance feedback.

Payoff. These findings provide insight into the design of effective CBT for digital systems, and have been briefed to the Land Warrior research community and to the Project Manager-Soldier Electronics/Land Warrior. Our research also demonstrated how CBT could be designed to incorporate tactical system software for background instruction and information screens, as well as for interactive screens used in the conduct of high-fidelity performance exercises.

Additional Information.

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Future Directions

Although Project Train Mod ended in late 2002, the need for training development research in conjunction with the acquisition and fielding of new systems continues. For that reason, issues from the 11 lines of investigation that encompassed Project Train Mod still exert substantial influence on our training research today.

For example, we continue to provide research supporting the Bradley Fighting Vehicle program, through an evaluation of Bradley gunnery training devices for the Army National Guard. In support of the evolving Land Warrior system, we are actively pursuing two lines of investigation, specifically, an analysis of Land Warrior training alternatives and a research project to identify training issues related to Land Warrior's digital interface with new combat vehicle technologies.

Results of Project Train Mod will transition to and directly support our new Science and Technology Objective (STO) concerned with training Objective Force Small Unit Leaders and Teams (STO #IV.SP.2003.06). Begun in FY03, this four-year research effort will develop new training methods and performance measures required to exploit new Objective Force capabilities and high-tech equipment. It will also develop exemplar training support packages that can be used by the Objective Force Warrior (OFW) Lead Technology Integrator (LTI) during the train-up phase of their Advanced Technology Demonstration (ATD). Annual STO goals and milestones are summarized in the following sections.

FY03

- Develop a metric for assessing the utility of new training technologies.
- Identify high-payoff tasks for embedded and virtual training.
- Identify potential small unit training technologies for mobility, survivability, lethality, and situation awareness/communications.
- Begin assessments of embedded training technologies for small unit leaders and teams.

FY04

- Identify Objective Force small unit leader decisions and leader dynamics.
- Establish an embedded/virtual training testbed.
- Adapt cutting edge instructional methods for representative OFW subsystems, including their operational tactics and training tasks.

FY05

- Demonstrate the after-action review feedback capabilities of wearable computers.
- Develop decision-making and information utilization measurement tools.
- Replicate selected OFW functions and effects to assess refined training methods

FY06

- Develop initial guidelines and instruction for small unit leader and team training to support the OFW ATD.
- Develop draft training support packages based on the most effective small unit leader and team training methods identified.
- Refine OFW training guidelines and instruction following ATD train-up and demonstration.

During the next four years, we will provide ongoing technical advisory services to the OFW program in the areas of training and human performance.

The OFW program is the Army's flagship Science and Technology initiative to develop and demonstrate revolutionary capabilities for Objective Force soldier systems.

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Click on the Search Scientific & Technical Documents link. Next, search for a particular report by entering its DTIC identification number, which is shown in bold type at the end of each ARI publication cited in this report (e.g., **ADA123456**).

A link to the DTIC website is also provided on ARI's website, where selected publications of current interest can also be downloaded as pdf files. Please visit:

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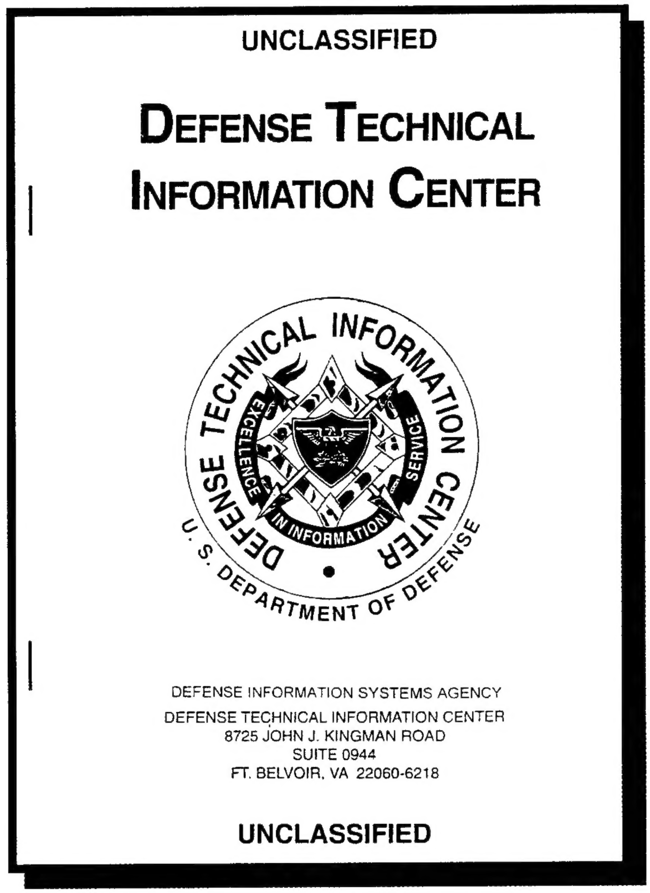

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REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
June 2003	Final	October 1998 - January 2003

4. TITLE AND SUBTITLE Project Train Mod: Modernizing Soldier Training Through Research	5a. CONTRACT OR GRANT NUMBER
	5b. PROGRAM ELEMENT NUMBER 62785
6. AUTHORS Kenneth L. Evans	5c. PROJECT NUMBER A790
	5d. TASK NUMBER 204
	5e. WORK UNIT NUMBER H01
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences Infantry Forces Research Unit P.O. Box 52086 Fort Benning, GA 31995-2086	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. MONITOR ACRONYM ARI
	11. MONITOR REPORT NUMBER Special Report 57

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 words)*:

This report summarizes and highlights the major findings of 11 separate lines of investigation across four general areas of applied training research: training modernization (5), decision making (2), situation awareness (2), and computer-based training for digital systems. The training modernization section focuses on training research for a variety of new systems and technologies, including the Land Warrior System and the M2A3 Bradley Fighting Vehicle. The section on decision making describes the development of new computer-based training tools for learning the Military Decision-Making Process (MDMP). It also provides an overview of research aimed at teaching platoon leaders to make better decisions during urban operations. The situation awareness (SA) section highlights the creation of a comprehensive infantry SA model, as well as the development and field testing of three new SA measures. Finally, the section on computer-based training presents survey research findings on the computer backgrounds of different groups of soldiers, as well as the results of a series of learning experiments that assessed the effectiveness of different computer-based instructional design features for training on new digital systems.

15. SUBJECT TERMS

Training Bradley Fighting Vehicle Land Warrior Computer Skills Decision Making Situation Awareness Computer-Based Training Training Impact Analysis Radio Communication Military Operations in Urban Terrain

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON (Name and Telephone Number)
16. REPORT	17. ABSTRACT	18. THIS PAGE			
Unclassified	Unclassified	Unclassified	Unlimited	36	Dr. Ken Evans (706) 545-2565